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PATENT SPECIFICATION

DRAWINGS ATTACHED

908,890

Date of filing Complete Specification: Dec. 11, 1958.

Application Date: Sept. 11, 1957. *No. 28685/57.*

Complete Specification Published: Oct. 24, 1962.

Index at acceptance:—Classes 47, A6; and 110(3), G5C(3X:4), G(9:11).

International Classification:—A62c. F02c.

COMPLETE SPECIFICATION

Improvements in and relating to Fire Fighting

I, DAVID JACOB RASBASH, of Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization, Boreham Wood, Elstree, Hertfordshire, a British subject, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with the control and extinction of fires.

The invention is based upon the provision of a high-speed current of gas of considerable quantity, and for this purpose it makes use of a gas current propelled by means of energy derived from a so-called gas turbine engine, that is to say, an internal combustion engine in which as much energy as possible is developed as kinetic energy in the products of combustion, the necessary compression pressure being attained by the aid of a compressor driven by a turbine, itself actuated by the burning gases; for the purpose in view the current is humidified, the humidity being present in the form of water vapour so that the current is transparent.

The invention consists both in the method above set forth and in apparatus which includes a gas turbine engine for producing a current of gas in a duct, and means for humidifying the current with water which remains in the current only in vapour form so that the current is transparent.

The gas current can be used in a number of ways in connection with fire fighting, as will be explained with reference to the accompanying diagrammatic drawings.

First, the engine may be used directly to induce a large flow of air, which may be used to ventilate a fire.

Although the blowing of air on to a fire may in some circumstances increase the fire, this is not necessarily a disadvantage if it blows away the smoke which hampers access to the fire. The use of fans for ventilating fires is known but a much greater flow can be obtained by the use of a gas turbine engine. For example, an engine of a size which can be carried on a trailer drawn by a fire-fighting appliance can produce a flow rate of air through a duct of the order of 50,000 to 100,000 cubic feet per minute. The exhaust gas may as shown in Fig. 1 be projected by an axial nozzle 11 into an air injector duct 12 of larger diameter than the nozzle and air be sucked into the duct 12 by induction. The mixture of exhaust gas and air so produced is then humidified, for example by introducing water spray by an axial nozzle 35 as in Fig. 2 or by an annular ring main 36 as in Fig. 3. Alternatively the engine may through a turbine actuated by the gases drive a high-speed fan placed in an air duct, which causes the motion of the air stream along the duct, the air then being humidified.

Another use for the gas turbine engine exhaust is for the production of a large flow of inert gas by which a hot flaming or smoking atmosphere can be displaced. To this end, the exhaust gas is humidified. By spraying water directly into the exhaust gas for example by nozzles as in Fig. 2 or 3, the water spray becomes vaporised and the gas therefore remains transparent. As a result the proportion of oxygen in the total bulk of gas is reduced, while the nitrogen content is also reduced and replaced with water vapour, which is a better suppressor of combustion. Due to the efficiency of combustion in a gas turbine engine, there is not likely to be much soot present and washing of the gas is therefore probably unnecessary. The gas in which the water spray has been vaporised is conducted or directed to the space in which the fire burns. The engine itself may supply the power to pump the water spray into a humidifier. The efficiency of conversion of water to water vapour may be improved by heating the water entering the humidifier to a temperature near the wet bulb

temperature of the gas. The humidifier may be so designed that a substantial part of the evaporation takes place within it, and in view of the pressure in the exhaust gas baffles may be provided in the humidifier to create turbulence, which assists the evaporation while permitting the gas to leave the humidifier with sufficient energy to overcome the resistance of the ducts conveying the gas into the building. Such baffles may be adjustable or removable to suit operating conditions and also to facilitate transport.

A convenient arrangement of engine, humidifier and ancillaries adapted to be mounted in a vehicle is shown in Figures 4 and 5, Fig. 4 being a plan view and Fig. 5 a side view. The engine is indicated at 16 and it is connected through a reheat section 17 to pipe section 18 serving as a humidifier, a cooling jacket being provided at 19. The general layout is of U form so that the final outlet 21 lies beside the air intake to the engine. Turbo-pumps for supplying the water to be sprayed into the humidifier are indicated at 22, driven by air bled off from the compressor of the engine and the water is injected through rows of spray nozzles 23. A fuel supply is indicated at 24, compressed air bottles for starting at 25 and a battery for ignition at 26. An engine such as 16 weighing a few hundredweights and burning 6 gallons of kerosene per minute can produce enough hot gas to give approximately 50,000 cubic feet per minute of inert gas, and a vehicle carrying a total weight of 3 tons could carry such an engine, together with the humidifier, collapsible ducting and ancillaries and fuel to run the appliance for 30 minutes.

It is desirable that complete saturation should take place in the humidifier, but if this cannot be achieved, further water spray at the wet bulb temperature may also be introduced into the gas at the entrance to or along ducting by which it is carried to the seat of the fire, again pumped by the power of the engine. Such ducting may be collapsible. By way of example, if the gas is completely saturated it may contain about 12 per cent. oxygen and 30 per cent. water vapour and be at a temperature of 75°C. A still lower oxygen content and higher water vapour content can be achieved by increasing the quantity of fuel burning in the tail pipe of the jet engine. If the oxygen content is brought below 7 per cent. this is sufficient to suppress smouldering under many conditions.

Another way of producing a large flow of inert gas using a gas turbine engine exhaust is by cooling the exhaust with cold water flowing at a rate greater than that required to humidify the exhaust gas. For example, if the gas were to be cooled to a temperature approximately 15°C higher than the inlet temperature of the cold water, a flow rate approximately 30 times greater than that required to humidify the exhaust gas would be required. The oxygen concentration of such cooled gas would not be appreciably less than the oxygen concentration in the exhaust of the engine and the water vapour concentration would correspond to the saturation concentration at the outlet temperature of the cooled gas. Provision is made as by a system of baffles to separate water drops from gas after the latter is cooled so that the gas current is rendered transparent. Inert gas formed in this way could find use in the production of atmospheres of sufficiently low temperature for men to work in without special protective clothing, yet having insufficient oxygen to allow flashback of flammable vapours and gases and flaming of common substances. The atmosphere may be used as a first step in reventilation following the extinction or control of a smouldering fire with inert gas.

A method which allows further control of the oxygen concentration of the inert gas is to use some of the inert gas produced by the engine and humidifier (or cooler), to replace some of the air entering the compressor of the jet engine. This would allow the overall fuel to air ratio in the engine to be increased without raising the temperature of the gas in the turbine unduly. As a result the inert gas produced although having a smaller flow rate would have a lower oxygen concentration than if there were no partial recirculation. In particular it is possible to divert some of the exhaust gas immediately following the combustion process and to cool the gas with a large flow rate of cold water before recirculating it to the compressor and to humidify the rest of the exhaust gas which is not so diverted.

Yet another use for the engine exhaust in fire fighting is simply the direction of the humidified current of exhaust gas or inert gas or air produced as above described at high velocity on to the fire, thereby deflecting the flames. Under some conditions, the application of the humidified current of exhaust gas or inert gas or air produced from the engine by any of the methods above described may be sufficiently powerful to extinguish flame by interfering with its aerodynamic stability. By means of such a current of gas, flames may be directed away from an object on fire in the open air—for example, a crashed aircraft—or, again the current may be used to sweep away burning spilled liquid fuel from around the object on fire or to push the object away from spilled fuel. The whole apparatus is suitably mounted on a vehicle which is propelled other than by the gas turbine engine so that it can be carried to the scene of the fire.

If it is desired that the velocity of ejection of the gas from the duct be greater than the velocity along the duct then a nozzle may be placed at the end of the duct of smaller cross-

sectional area than the area of the duct. If it is desired that the velocity of ejection of gas from the duct be less than velocity in the duct, while the main length of the duct is made of closely woven fabric or other material relatively impervious to gas the final portion of the length of duct may be constructed of filter fabric or other open mesh material which will allow gas to flow through the walls of the duct.

In several of the above described applications, collapsible ducts are referred to. Such ducts may be made of woven fabric and arranged to collapse flat, similarly to fire hose, or if any negative pressure is to be expected, they may be reinforced helically and collapsed lengthwise.

WHAT I CLAIM IS:—

1. A method of fire-fighting which comprises propelling a current of humidified gas towards the vicinity of the fire by means of energy derived from a gas turbine engine the humidity being present in the form of water vapour so that the current is transparent.

2. A method according to Claim 1 in which the gas is a mixture of the exhaust gas of the engine and air induced by ejector action of the exhaust gas.

3. A method according to Claim 1 in which the gas is air propelled by a high speed fan driven by the engine and located in an air-duct.

4. A method according to Claim 1 in which the gas is the exhaust gas of the engine.

5. A method according to Claim 4 in which the gas is only partially humidified in a humidifier and further water heated to a temperature near the wet bulb temperature of the gas is introduced into the gas after leaving the humidifier.

6. A method according to Claim 4 in which the exhaust gas is cooled and humidified with a large flow rate of cold water, and the drops of water are thereafter removed from the current.

7. A method according to Claim 4, 5 or 6 in which the oxygen content of the gas is reduced by diverting some of it into the intake of the engine so replacing some of the air intake thereby.

8. A method according to any of the preceding claims in which the engine provides the power for pumping the water used for humidifying or humidifying and cooling the current of gas.

9. A method according to any of the preceding claims in which the current of gas is projected towards a fire in an enclosed space to blow away smoke and render the fire accessible.

10. A method of preserving a burning object or material from further deterioration by fire which comprises directing upon it the humidified current of gas produced in the manner claimed in any of claims 1 to 8 of such intensity as to extinguish the flame.

11. A method of preventing the spread of fire from a burning object or material to another object or material which comprises so directing the humidified current of gas produced in the manner claimed in any of claims 1 to 8 as to deflect flames from the burning object or material away from the other object or material or to displace the other object or material away from the burning object or material.

12. Fire fighting apparatus including a gas turbine engine for producing a current of gas, means for humidifying the current with water which remains in the current only in vapour form so that the current is transparent, a duct for directing the humidified current towards the vicinity of a fire, and a carrying vehicle propelled by means other than said gas turbine.

13. Apparatus according to Claim 12 in which the humidifying means is arranged so as not to cool more water than will saturate the gas current.

14. Apparatus according to Claim 12 in which the humidifying means adds more water than will saturate the gas current and the excess is then removed.

15. Apparatus according to Claim 12, 13 or 14 in which the exhaust gas of the engine is discharged into an air ejector duct whereby air is induced into the duct to produce a current of air which with the exhaust gas admixed constitutes the gas current.

16. Apparatus according to Claim 12, 13 or 14 in which the engine drives a high speed fan in an air duct, the air current so propelled constituting the gas current.

17. Apparatus according to Claim 13 in which the exhaust gas of the engine is discharged through a humidifier into a duct wherein it constitutes the gas current, the water being sprayed into the humidifier for vaporisation in the exhaust gases.

18. Apparatus according to Claim 17 in which part only of the water is added by means of the humidifier and means are provided to heat the remainder of the water to a temperature near the wet bulb temperature of the gas and spray it into the duct at a point after the humidifier.

19. Apparatus according to Claim 14 in which the exhaust gas of the engine is discharged into a duct wherein it constitutes the gas current, and the means for adding water sprays cold water into the duct at a sufficient rate to saturate and cool down the gas, further means serving to remove the drops of water from the current.

20. Apparatus according to any of claims 12 to 19 in which power for pumping the water to be added to the gas into the duct is obtained from the engine.

21. Apparatus according to any of claims 12 to 20 in which the duct terminates in a

discharge nozzle for the humidified current of gas, and the whole is so constructed or mounted that at least the nozzle can be taken to the scene of a fire and its direction of discharge be varied.

22. Apparatus according to any of claims 12 to 21 in which the duct is constructed from closely woven fabric or some other material that is relatively impervious to gas and terminates in a final portion of filter fabric or other open mesh material through which gas can flow.

23. Apparatus for use in fire fighting substantially as described with reference to Figs. 1 and 2 or Figs. 1 and 3 of the accompanying drawings.

24. Apparatus for use in fire fighting substantially as described with reference to Figures 4 and 5 of the accompanying drawings.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press (Leamington) Ltd.—1962. Published by The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

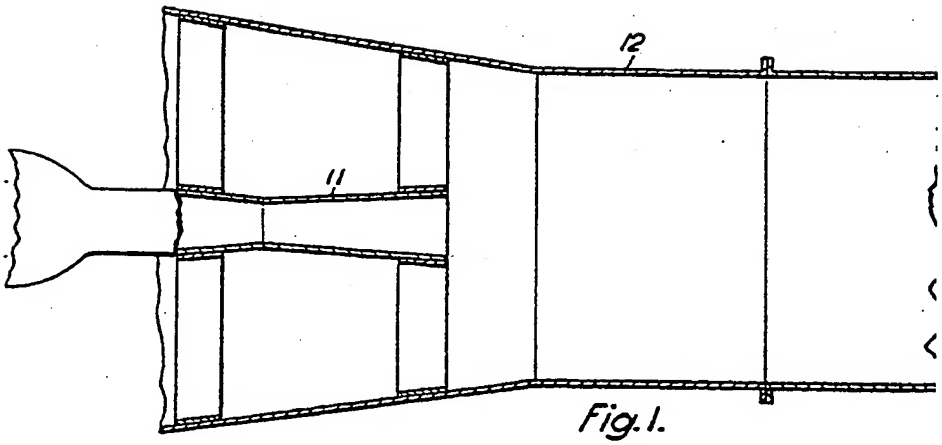

Fig. 1.

COMPLETE SPECIFICATION

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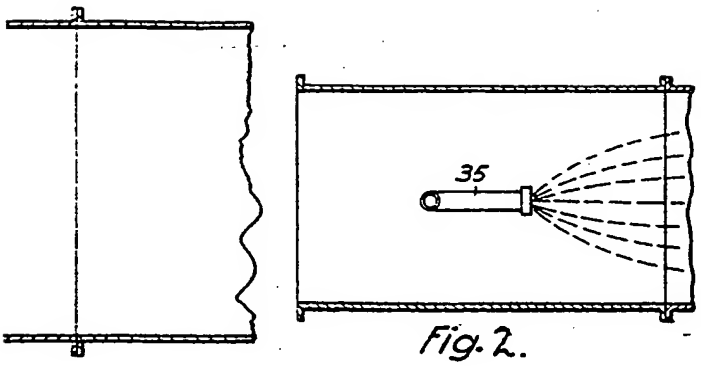

Fig. 2.

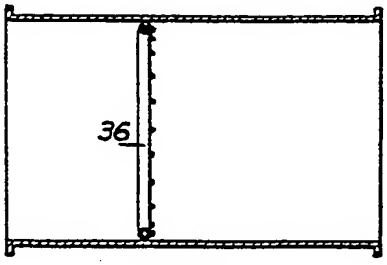

Fig. 3.

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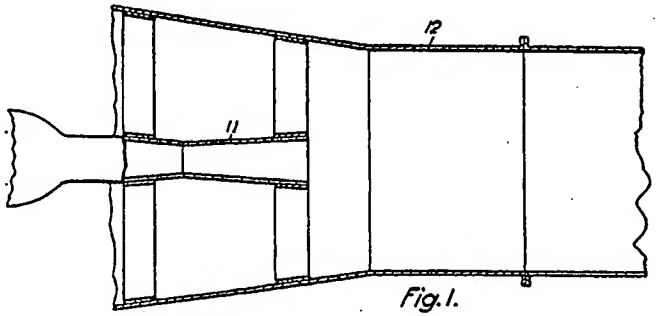

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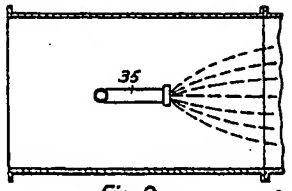


Fig. 2.

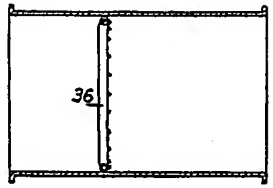


Fig. 3.

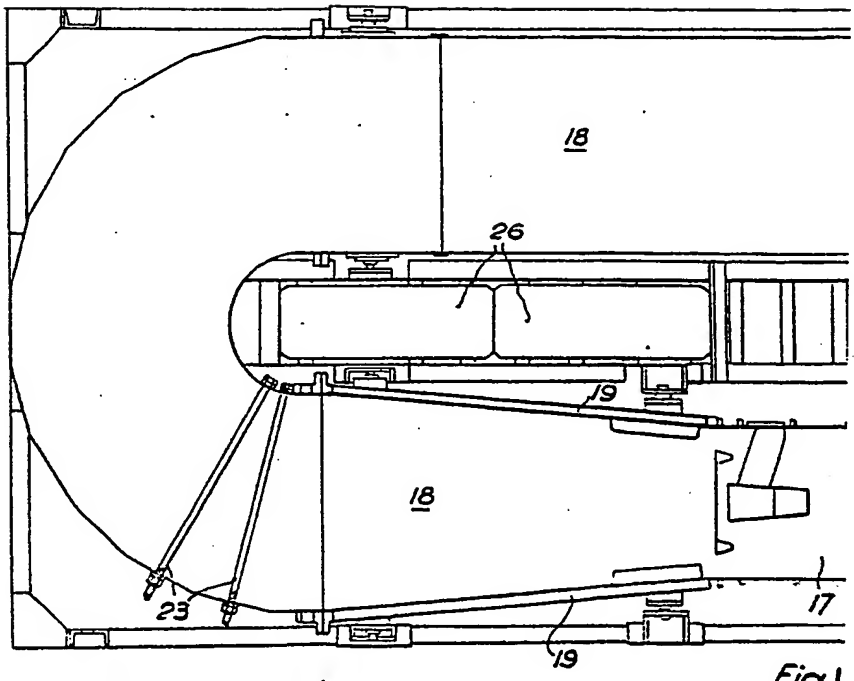
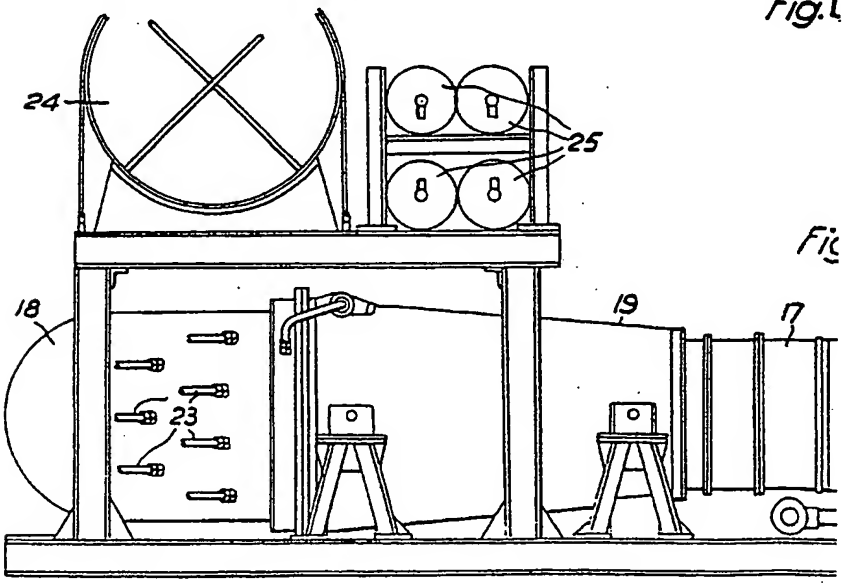


Fig. 1



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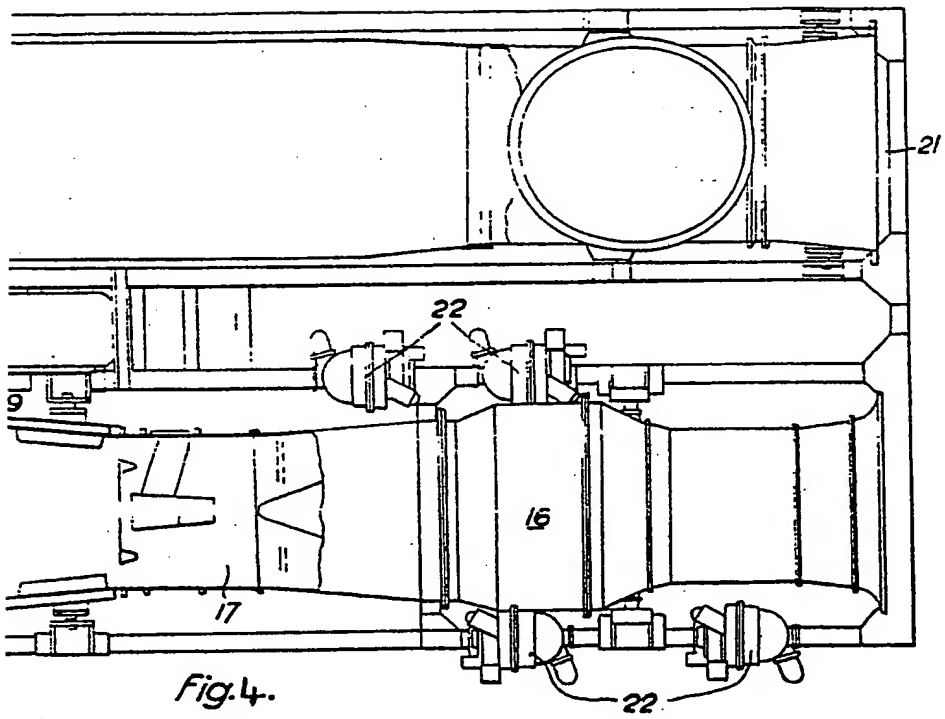

Fig. 4.

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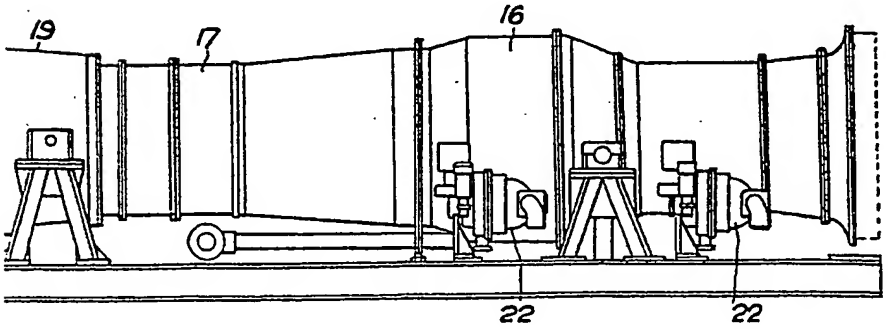
Fig. 5.



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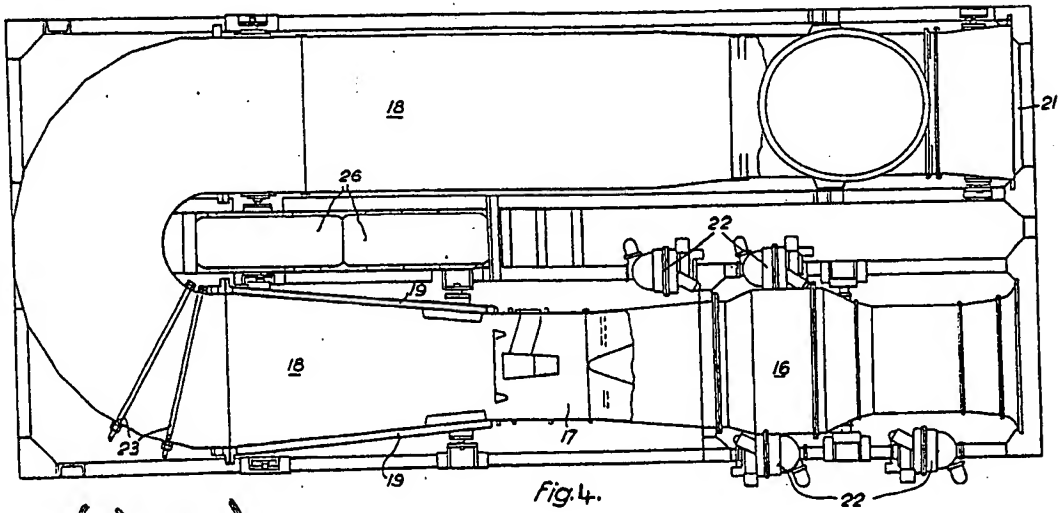

Fig.4.

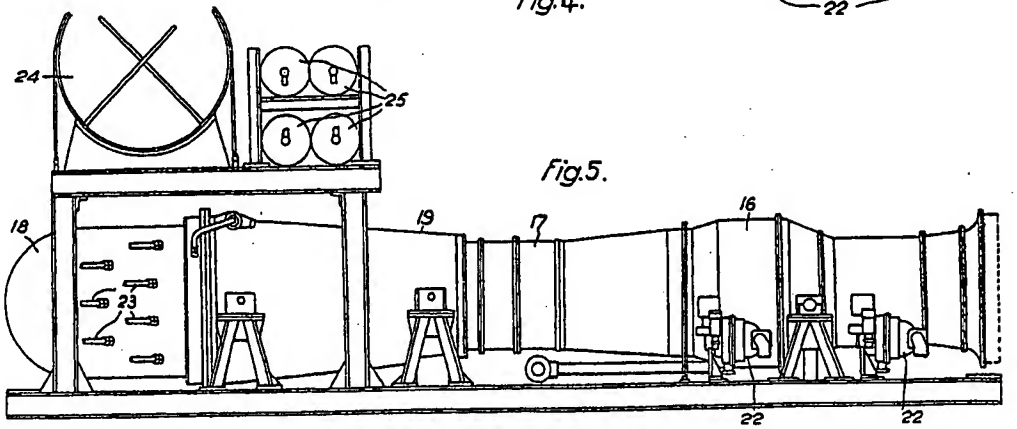

Fig.5.